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ORIGINAL ARTICLE

Applying Rogers' framework to evaluate public awareness and knowledge of medical genetics in a developing country

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Abstract

Public knowledge of medical genetics is essential for better establishment of its services but has been rarely evaluated based on distinguished types of knowledge. We designed and validated a new self-administered questionnaire in Farsi (Persian language) to assess public knowledge of medical genetics based on Rogers' framework. This framework divides knowledge into three types of awareness, how-to (practical) and principles knowledge which refer to knowing the existence, proper use, and theoretical principles of an innovation, respectively. We asked consecutive individuals ($n = 306$, age ≥ 20 years) visiting health centers in different regions of Yazd, a city in central Iran, to fill out the questionnaire. After validation, we analyzed 280 of the questionnaires which revealed a high degree of internal consistency (Cronbach's alpha 0.90) and a positive linear relationship among the scores of different knowledge. Our respondents had relatively fair awareness and how-to, but generally poor principles knowledge with statistically significantly better scores in females and those with higher education. We observed tangible strengths in topics such as consanguineous marriage, thalassemia, and hereditary predisposition to diabetes and cardiovascular disorders, and weaknesses in areas such as genetic testing and genetics of cancer. Notably, experience of premarital genetic counseling did not show any significant effect, but having a relative with a genetic disorder was significantly linked to better awareness scores. Our study provides a reliable and self-administered questionnaire for the assessment of public knowledge of medical genetics. Despite revealing important strengths and weaknesses in our population sample, larger scale evaluations in Iran and other developing countries are needed for better understanding of the public knowledge as the prerequisite for designing appropriate educational programs.

Keywords Medical genetics · Public knowledge · Public awareness · Rogers' framework · Yazd · Iran

Introduction

Human genetics dates back to the ancient and medieval history when the first observations on inheritance of some human physical traits and disorders have been documented (Speicher et al. 2010; Asadollahi and Asadollahi 2013). In the twentieth century, human genetics entered a new era by the application of Mendel's laws, description of many genetic disorders, and the possibility to evaluate chromosomes and genes by karyotyping, fluorescent in situ hybridization, and gene sequencing (Kumar and Eng 2015). Since the completion of Human Genome Project in 2003 (Collins et al. 2003) and by the advent of molecular karyotyping and next generation sequencing, human genetics has been increasingly influencing medicine by the discovery of genetic cause or susceptibility in many different disorders (Kumar and Eng 2015).

Beside the advancement of science and technology, public awareness and knowledge about medical genetics and its services are essential for better establishment of current genetic services and their increasing role in near future of medicine. Accordingly, latest consultation report of the World Health Organization on community genetics services has emphasized on public education and increasing the genetic literacy

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especially in low- and middle-income countries, which can lead to better understanding and application of genetic services (World Health Organization 2011).

The prerequisite for public education is to evaluate their level of knowledge in order to determine the needs and priorities. However, only a limited number of studies have focused on evaluation of public awareness and knowledge about human and medical genetics (Henneman et al. 2004; Molster et al. 2009; Smerecnik et al. 2011); most of which have not distinguished different levels of knowledge, and importantly no study on that has been performed in Iran. Therefore, we designed and validated a semi-structured and self-administered questionnaire to evaluate distinct levels of public knowledge about medical genetics in Iran.

Methods

We designed a semi-structured and self-administered questionnaire based on Rogers' knowledge framework and performed a descriptive and cross-sectional study to validate that in evaluating public awareness, how-to (practical) and principles knowledge of medical genetics in a population sample of 280 individuals from Yazd, a city in central Iran.

Rogers' knowledge framework

Everett Rogers has proposed knowledge as the first step for acceptance of an innovation. Knowledge has been then divided into three types including awareness which refers to knowing the existence of an innovation, how-to (practical) which concerns the proper use of it, and principles as theoretical principles of the innovation (Rogers 2003). This framework has been previously applied for evaluation of public knowledge (Smerecnik et al. 2011, 2008).

Design of the questionnaire

We designed a questionnaire in Farsi (Persian language) (supplementary information) consisting of eight sociodemographic questions (gender, age, occupation, level of education, field of study, marital status and if consanguineous marriage, number of children and the last child's birth year), two questions related to participants' personal experience with medical genetics (if they had premarital genetic counseling, if they had a relative with a congenital genetic disorder), one question about their self-reported estimate of knowledge of medical genetics, and 34 main questions evaluating awareness knowledge (10 questions), how-to knowledge (12 questions), and principles knowledge (12 questions). We considered four categories of questions for each type of knowledge including concepts and definitions, genetic counseling, genetic and hereditary disorders, and genetic testing (Table S1). Overall, the questionnaire contains 34 yes/no or multiple-choice questions, and five open-ended questions. We also included a question about the preferable source of receiving educational genetic information by each respondent.

We assigned one point for each "yes" answer and zero point for each "no" answer in the awareness knowledge section, and one point for each "correct" answer and zero point for each "incorrect," or "I don't know" answer in how-to and principles knowledge sections. Median and mean scores equal or higher than half of the total possible score were considered as "relatively fair," and those of lower than half were considered as "generally poor" knowledge.

In order to estimate the reliability and internal consistency of the questionnaire, we measured Cronbach's alpha firstly in a pilot sample of 96 people, and then in the total cohort.

Selection of the target population

We collected our target population from those visiting outpatient healthcare centers in Yazd, a city located in central Iran. Yazd is a historic city recognized as a World Heritage Site by UNESCO (UNESCO website) with an area of about 180 km^2 and a population of about 610,000 people according to the Iranian Census of 2016. Sixty seven percent of the population have been reported to be ≥ 20 years old, and among them were ~ 49% female, ~ 51% male, ~ 81% married, and ~ 92% literate (Table S3) (SCI 2011/2016). The majority of the population (~ 99%) are Muslims and the minority (~ 1%) are Zoroastrians (followers of Zoroastrianism, an ancient Persian religion), Jews, or Christians (SCI 2011/2016).

We divided the city into five geographical regions of center, east, west, north, and south, and selected two healthcare centers in each region. In each healthcare center, we asked at least 30 consecutive individuals who were ≥ 20 years old and had a minimum literacy of primary school for filling out the questionnaire after explaining them about the purpose of the study and their agreement. In total, 306 people filled out the questionnaire.

Statistical analysis

We performed Kolmogorov-Smirnov (KS) and Shapiro-Wilk (SW) analyses to determine the probability distribution of scores. We conducted nonparametric statistical Mann-Whitney and Kruskal-Wallis tests for comparisons and Spearman rank-order correlation test to determine the relationship between the types of knowledge. We measured the Cronbach's alpha in order to estimate the reliability and internal consistency of the questionnaire.

For all analyses, $p < 0.05$ was considered statistically significant. All the statistical analyses were performed by the SPSS software package (version16.0, Chicago, IL, USA).

Results

Cohort characteristics

In total, 280 of the 306 filled questionnaires were included in the study, and 26 were excluded because of gaining a total score of zero from five questions with the highest frequency of correct answers in the total cohort. Among the 280 included respondents, 134 (47.9%) were female and 146 (52.1%) were male. The majority of the respondents were between the ages of 20–40 (76.1%) and were married (72.5%). The respondents which had high school diploma or higher education were 84.7%, and most of them had an occupation (94.2%) or educational field (65.7%) unrelated to biology or health services. Among the respondents who were married, 28.4% had consanguineous marriage (first or second cousins) and 16.6% had experienced premarital genetic counseling. The respondents which were reported to have a relative with a congenital genetic disorder were 16.8%. In the self-reported estimate of knowledge, 55.6% of the respondents rated themselves to have "no" or "a little" knowledge about medical genetics, and 28.2% rated "to some extent" or "a lot." The rest were unsure (15.3%) or did not answer (0.8%). Details of sociodemographic characteristics, participants' personal experience with medical genetics, and self-reported estimate of knowledge are presented in Table S2.

While distributions of gender and marital status were comparable between our respodents and Yazd general population, people between the ages of 20–26 and those with educational level of bachelor or higher were over-represented, and people with ages of ≥ 42 years and educational level of below high school diploma were under-represented in our sample (Table S3).

At the end of the questionnaire, we asked about the preferable source of receiving educational genetic information by each respondent who mainly selected television and radio (40.7%), and the Internet (25.7%) as their preferable sources (Table S4).

Internal consistency and relationship between scores of different knowledge

Cronbach's alpha in the first pilot sample (96 people) was 0.88 which increased to 0.90 in the total cohort (280 people). Our Spearman rank-order correlation analysis revealed a strong positive relationship between awareness and how-to knowledge ($r_s = 0.600$, $p < 0.01$) (Fig. 1b), awareness and principles knowledge ($r_s = 0.575$, $p < 0.01$) (Fig. 1c), and how-to and principles knowledge ($r_s = 0.741$, $p < 0.01$) (Fig. 1d).

Awareness knowledge

The median score of awareness knowledge in the total cohort was 6 (mean: 6.3 ± 2.4) ranging from 0 to 10 (Fig. 1a). Awareness knowledge was statistically significantly related to gender, occupation, educational level, field of study, and number of children, having a relative with a congenital genetic disorder and self-estimated knowledge of medical genetics ($p < 0.05$, Table S5).

Evaluation of the responses revealed that on average, ~ 60–70% chose "yes" for those questions about the concepts and definitions, genetic counseling (Fig. 2a), and genetic and hereditary disorders (Table 1) indicating that they have heard of them.

Notably, ~ 88% (highest awareness) reported to have heard of the risk of congenital genetic disorders following consanguineous marriage (including ~ 82% of those with consanguineous marriage). However, only ~ 34% had heard about the possibility of preventing congenital genetic disorders; among them, ~ 80% were able to name a possibility (Fig. 2b). Most of the respondents had heard about hereditary (~ 78%) and congenital genetic disorders (~ 67%); among them, ~ 90% mentioned at least one disorder which the majority were diabetes and cardiovascular diseases (Fig. 2c).

The lowest awareness was related to the question of having heard of genetic testing (~ 35%); among them, only ~ 9% could name a test which included karyotyping and counting the number of chromosomes, screening tests, and amniocentesis.

How-to knowledge

The median score of how-to knowledge in the total cohort was 7 (mean: 6.9 ± 2.9) ranging from 0 to 14 (Fig. 1a). How-to knowledge was statistically significantly related to gender, marital status, occupation, educational level, field of study, number of children, the last child's birth year, and self-estimated knowledge of medical genetics ($p < 0.05$, Table S6).

Evaluation of the responses revealed that on average ~ 39% chose the correct answers to the questions about basic concepts and definitions, and ~ 50–60% to those about genetic counseling, genetic and hereditary disorders, and genetic testing (Table 2).

Notably, ~ 65% of the respondents answered correctly that healthy parents could have a child with a hereditary disorder, but ~ 39% and ~ 37% of them knew that the carrier of a disease gene may be completely healthy, or the child of a carrier of a genetic disorder will not always be a carrier of the same disorder, respectively.

Moreover, ~ 68% of the paticipants knew the higher chance of chromosomal abnormalities in the children of mothers getting pregnant at advanced age, and ~ 49%

answered correctly to the question about the border age considered as an advanced maternal age.

The highest (~ 74%) how-to knowledge was on the possiblility to prevent the onset of multifactorial disorders by appropriate lifestyle in a person with genetic susceptibility, and the lowest (~ 11%) was related to the characteristics of familial cancer syndromes (Table 2).

Principles knowledge

The median score of principles knowledge in the total cohort was 3.5 (mean: 4.1 ± 3.4) ranging from 0 to 14 (Fig. 1a). Principles knowledge was statistically significantly related to gender, age, marital status, occupation, educational level, field of study, number of children, and self-estimated knowledge of medical genetics ($p < 0.05$, Table S7).

Evaluation of the responses revealed that on average, ~ 22% chose the correct answers to the questions about basic consepts and definitions and genetic counseling, ~ 46% to those about genetic and hereditary disorders, and ~ 11% to genetic testing (Table 3).

Notably, the highest (~ 63%) principles knowledge was on selecting a genetic disorder which presents with anemia and is relatively common in Iran compared to some other countries, and the lowest (~ 5%) was related to the cancer which is linked to *BRCA1* gene (Table 3).

Discussion

Our study is the first to design a reliable questionnaire to evaluate distinguished types of knowledge of medical genetics among public based on Rogers' framework. Our results revealed a high degree of internal consistency of the questionnaire and positive linear relationships among the scores of awareness, how-to, and principles knowledge. Among the respondents to the questionnaire in Yazd, a city in central Iran, we found relatively fair awareness and how-to, but generally poor principles knowledge, with some tangible strengths in topics such as consanguineous marriage, thalassemia, and hereditary predisposition to diabetes and cardiovascular disorders, and weaknesses in areas such as genetic testing and genetics of cancer. While previous studies using Rogers'

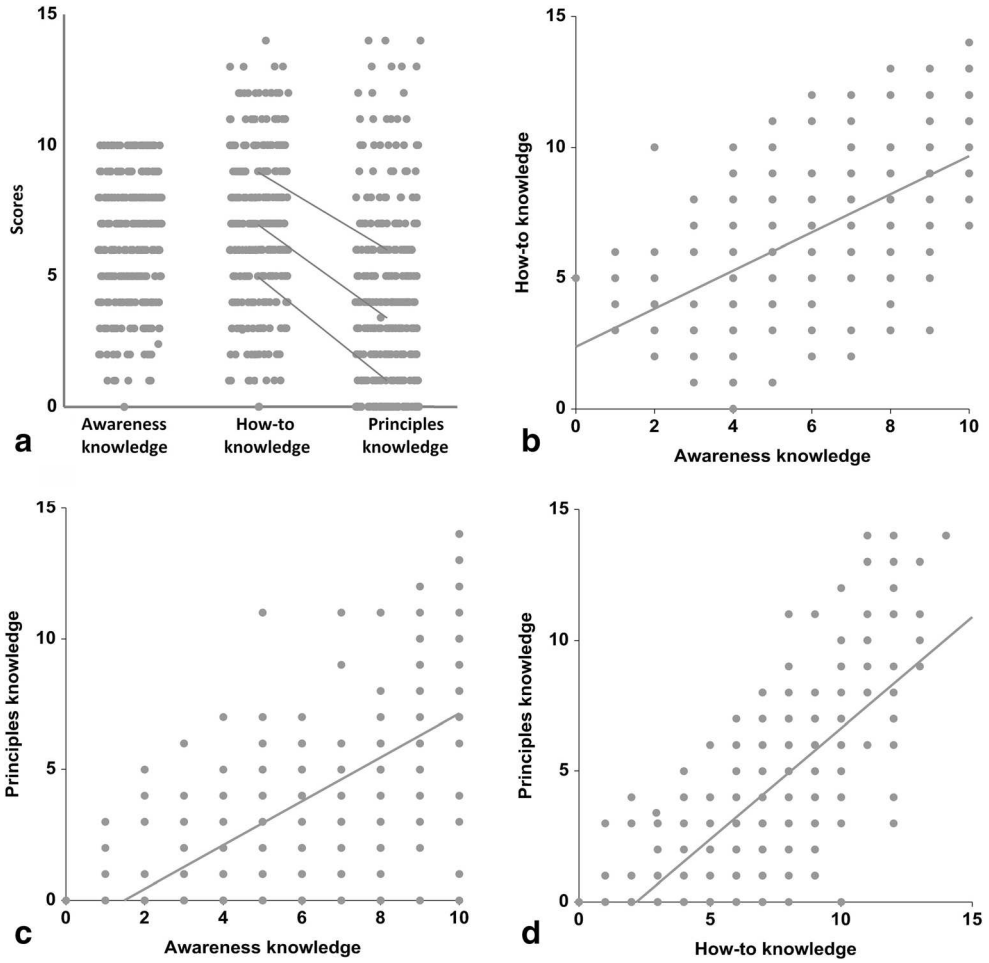

Fig. 1 Distribution of awareness, how-to (practical), and principles knowledge scores in the total cohort and the correlation between the respective scores. Dot plot in (**a**) shows the distribution of scores with maximum score of 10 in the awareness knowledge, and 14 in how-to and principles knowledge. Connecting lines indicate 75th percentile, median, and 25th percentile of the scores in how-to and principles knowledge. Scatter plots (**b**–**d**) show a positive correlation between awareness and how-to knowledge ($r_s = 0.600$, $p < 0.01$) (**b**), positive correlation between awareness and principles knowledge ($r_s = 0.575$, $p < 0.01$) (**c**), and positive correlation between how-to and principles knowledge ($r_s = 0.741$, $p < 0.01$) (**d**)

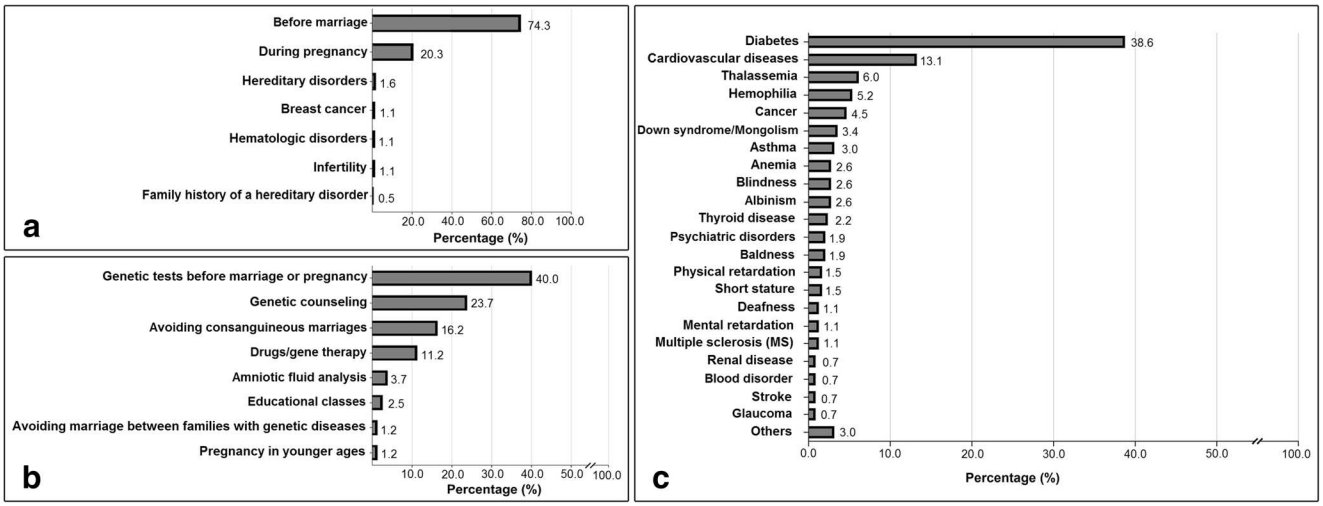

Fig. 2 Respondents' answers to three open-ended questions of awareness knowledge. Bar graphs show the percentages of indications of genetic counseling reported by those who have heard of genetic counseling (**a**), possible ways to prevent congenital genetic disorders (**b**), and hereditary and genetic disorders (**c**) reported by those who have heard of them. Others (**c**) include phenylketonuria, epilepsy, muscular weakness, amblyopia, skin diseases, vitiligo, allergy, and AIDS; each reported only once

knowledge framework focused only on specific topics in medical genetics such as genetic risk factors (Smerecnik et al. 2011) or multifactorial genetic diseases (Smerecnik et al. 2008), they also showed similar patterns of reasonable awareness and how-to compared to highly inadequate principles knowledge.

Strengths in the aforementioned areas are very likely due to the more common social interactions and experience with these issues (Condit 2010; Richards and Ponder 1996) and better coverage of these topics in the media of Iran. Better understanding of the public about hereditary predisposition to diabetes and cardiovascular disorders has also been previously reported in different populations (Molster et al. 2009; Jallinoja and Aro 2000; Bates et al. 2003).

The weakness in the cancer-related topics such as the link between *BRCA1* gene and breast cancer may imply weaker medical implementation of this topic as well as the media coverage of cancer genetics in Iran compared to developed countries with better public knowledge in this regard (Fogleman et al. 2019; MacNew et al. 2010).

When categorizing our questions into four groups of concepts and definitions, genetic counseling, genetic and hereditary disorders, and genetic testing, we observed relatively fair knowledge of genetic counseling, genetic and hereditary disorders compared to generally poor knowledge of concepts and definitions, and genetic testing. Other studies, though did not distinguish different types of knowledge, have also shown limited knowledge of genetic concepts and terminology (Henneman et al. 2004; Kessler et al. 2007), or low levels of awareness about basic principles, but acceptable knowledge of association between genes, heredity, and diseases (Jallinoja and Aro 2000) in different populations.

In our evaluation, we observed significantly higher scores in all the three types of knowledge in female respondents, and those with higher levels of education. Although similar expectable effects of educational level have been previously shown (Molster et al. 2009; Smerecnik et al. 2011), the link between gender and public knowledge of genetics has been contradictory (Henneman et al. 2004; Jallinoja and Aro 2000; Morris et al. 2003). Female respondents in our study were statistically significantly younger than male respondents which may indicate their more recent education and therefore better coverage of genetics in their biology curricula, and enhanced recall of the information. The same might be true for our observation of significantly higher scores of principles knowledge among younger participants.

Notably, experience of premarital genetic counseling did not have a significant effect on the scores of knowledge, but having a relative with a congenital genetic disorder was significantly linked to higher scores of awareness knowledge. We had a limited number of respondents with biology/health-related fields of study or occupations who were unsurprisingly better in all the three types of knowledge.

Importantly, comparison of the self-estimated knowledge of the respondents about medical genetics and their factual scores revealed that those with higher self-estimated knowledge had also higher scores in all the three categories. Similar results have been shown in previous studies (Henneman et al. 2004; Molster et al. 2009) which together may indicate reasonable estimate of people from their level of knowledge.

Conclusion

In conclusion, our study provides a reliable and self-administered questionnaire for the assessment of public

Table 1 Frequency of answers to the questions of awareness knowledge in the total cohort

No	Category	Questions of awareness knowledge	Frequency of answers (%)
1	Concepts and definitions	Do you know which factor in human body controls the inheritance (inherited characteristics)?	
		No	162 (57.5%)
		Yes	117 (41.8%)
		Not available	1 (0.4%)
2	Concepts and definitions	Have you ever heard of "gene"?	
		No	35 (12.5%)
		Yes	245 (87.5%)
		Not available	0 (0%)
3	Concepts and definitions	Have you ever heard of "chromosome"?	
		No	57 (20.4%)
		Yes	223 (79.6%)
		Not available	0 (0%)
4	Concepts and definitions	Have you ever heard of "medical genetics"?	
		No	124 (44.3%)
		Yes	155 (55.4%)
		Not available	1 (0.4%)
5	Genetic counseling	Do you know what genetic counseling is done for?	
		No	92 (32.9%)
		Yes	187 (66.8%)
		Not available	1 (0.4%)
		If yes, please name at least one of them: "all answers"	187
6	Genetic and hereditary disorders	Have you ever heard of hereditary disorders?	
		No	61 (21.8%)
		Yes	218 (77.9%)
		Not available	1 (0.4%)
		If yes, please name at least one of them: "all answers"	267
7	Genetic and hereditary disorders	Have you ever heard of congenital genetic disorders?	
		No	87 (31.1%)
		Yes	187 (66.8%)
		Not available	6 (2.1%)
8	Genetic testing	Have you ever heard of genetic testing (on chromosomes or genes)?	
		No	181 (64.6%)
		Yes	97 (34.6%)
		Not available	2 (0.7%)
		If yes, please name at least one of them: "all answers"	9
9	Genetic counseling	Have you ever heard of the risk of hereditary or congenital disorders following consanguineous marriage?	
		No	31 (11.1%)
		Yes	247 (88.2%)
		Not available	2 (0.7%)
10	Genetic counseling	Do you know if it is possible to prevent congenital genetic disorders?	
		No	184 (65.7%)
		Yes	96 (34.3%)
		Not available	0 (0%)
		If yes, please name at least one possibility: "all answers"	78

Table 2 Frequency of answers to the questions of how-to (practical) knowledge in the total cohort

No	Category	Questions of how-to (practical) knowledge	Frequency of answers (%)
1	Concepts and definitions	Could healthy parents have a child with a hereditary disorder?	
		True (yes)	183 (65.4%)
		False/I do not know	97 (34.6)
		Not available	0 (0%)
2	Concepts and definitions	May the carrier of a disease gene be completely healthy?	
		True (yes)	108 (38.6%)
		False/I do not know	170 (60.7%)
		Not available	2 (0.7%)
3	Concepts and definitions	Will the child of a carrier of a genetic disorder be always a carrier of the same disorder?	
		True (no)	103 (36.8%)
		False/I do not know	176 (62.9%)
		Not available	1 (0.4%)
4	Concepts and definitions	In which gender there is a higher possibility of having some of the X-linked disorders such hemophilia?	
		True (men)	37 (13.2%)
		False/I do not know	243 (86.8%)
		Not available	0 (0%)
5	Genetic counseling	Which group does need genetic counseling?	
		True (families with history of genetic disorders)	192 (68.6%)
		False/I do not know	88 (31.4%)
		Not available	0 (0%)
6	Genetic testing	What is the most common sample for genetic testing?	
		True (blood)	203 (72.5%)
		False/I do not know	77 (27.5%)
		Not available	0 (0%)
7	Genetic testing	For which condition(s) chromosomal analysis is performed?	
		True (problems in development and growth, and infertility)	64 (22.9%)
		False/I do not know	216 (77.1%)
		Not available	0 (0%)
8	Genetic and hereditary disorders	According to the fact that in recent years researchers have discovered the role of genetic susceptibility in many chronic disorders such as diabetes and cardiovascular diseases, if a person has a hereditary susceptibility to one of these disorders, will this person certainly get the disease?	
		True (no)	135 (48.2%)
		False/I do not know	144 (51.4%)
		Not available	1 (0.4%)
		Is it possible to prevent the onset of the disease by appropriate lifestyle?	
		True (yes)	208 (74.3%)
		False/I do not know	71 (25.4%)
		Not available	1 (0.4%)
		May the person's children also be susceptible to the disease?	
		True (yes)	200 (71.4%)
		False/I do not know	79 (28.2%)
		Not available	1 (0.4%)
9	Genetic counseling	What is correct about the chance of having children with genetic disorders in consanguineous families?	
		True (the chance is higher for some genetic disorders)	161 (57.5%)
		False/I do not know	119 (42.5%)
		Not available	0 (0%)
10	Genetic counseling	What is considered as the border of advanced maternal age for pregnancy?	
		True (35)	137 (48.9%)
		False/I do not know	137 (48.9%)
		Not available	6 (2.1%)
11	Genetic counseling	What is correct about the pregnancy at advanced maternal age?	
		True (higher chance of chromosomal abnormalities in the child)	191 (68.2%)
		False/I do not know	83 (29.6%)
		Not available	6 (2.1%)
12	Genetic and hereditary disorders	Which of the following features are characteristic of familial cancer syndromes?	
		True (two or more primary tumors in a person, cancer at young age)	32 (11.4%)
		False/I do not know	242 (86.4%)
		Not available	6 (2.1%)

Table 3 Frequency of answers to the questions of principles knowledge in the total cohort

No		Questions of principles knowledge	Frequency of answers (%)
1	Concepts and definitions	Which parts of chromosomes are responsible for producing protein?	
		True (genes)	62 (22.1%)
		False/I do not know	212 (75.7%)
		Not available	6 (2.1%)
2	Concepts and definitions	What does the term "genome" refer to?	
		True (an organism's complete set of DNA)	62 (22.1%)
		False/I do not know	212 (75.7%)
		Not available	6 (2.1%)
3	Concepts and definitions	Approximately how many genes does a human being have?	
		True (25000)	30 (10.7%)
		False/I do not know	244 (87.1%)
		Not available	6 (2.1%)
4	Concepts and definitions	How many pairs of autosomal and how many pairs of sex chromosomes does a human being have?	
		True (22, 1)	62 (22.1%)
		False/I do not know	212 (75.7%)
		Not available	6 (2.1%)
5	Concepts and definitions	If a person has an X and a Y chromosome, that person is:	
		True (male)	95 (33.9%)
		False/I do not know	185 (66.1%)
		Not available	0 (0%)
6	Genetic testing	Which cells of the body are more suitable for genetic testing?	
		True (white blood and skin cells)	48 (17.1%)
		False/I do not know	232 (82.9%)
		Not available	0 (0%)
7	Genetic and hereditary disorders	What is the cause of Down's syndrome (called Mongolism previously)?	
		True (increase in the number of chromosome21)	33 (11.8%)
		False/I do not know	247 (88.2%)
		Not available	0 (0%)
8	Genetic and hereditary disorders	Which genetic disorder does present with anemia and is relatively more common in Iran compared to some other countries?	
		True (thalassemia)	177 (63.2%)
		False/I do not know	103 (36.8%)
		Not available	0 (0%)
9	Genetic testing	Which cancer is linked to BRCA1 gene?	
		True (breast cancer)	15 (5.4%)
		False/I do not know	265 (94.6%)
		Not available	0 (0%)
10	Genetic counseling	Which option does more likely lead to congenital genetic disorders with chromosomal abnormalities:	
		True (problems in sperm or egg)	90 (32.1%)
		False/I do not know	190 (67.9%)
		Not available	0 (0%)
11	Genetic counseling	If a couple are both carriers of a defect in a gene causing an autosomal recessive disorder, what is their chance of having a child affected by the disorder in each pregnancy?	
		True (25%)	33 (11.8%)
		False/I do not know	146 (87.9%)
		Not available	1 (0.4%)
12	Genetic and hereditary disorders	From the following disorders, which are caused only by genetic factors and which by both genetic and environmental factors?	
		Hemophilia:	
		True (only genetic factors)	128 (45.7%)
		False/I do not know	148 (52.9%)
		Not available	4 (1.4%)
		Cardiovascular disorders:	
		True (both genetic and environmental factors)	156 (55.7%)
		False/I do not know	123 (43.9%)
		Not available	1 (0.4%)
		Cancer	
		True (both genetic and environmental factors)	151 (53.9%)
		False/I do not know	126 (45.0%)
		Not available	3 (1.1%)

knowledge of medical genetics and is the first to evaluate that based on Rogers' framework. Despite revealing important strengths and weaknesses in our population sample, larger scale evaluations in Iran and other developing countries are needed for better understanding of the public knowledge as the prerequisite for designing appropriate educational programs to address common misconceptions and introduce available services (World Health Organization 2011). Since the majority of our respondents selected television and the Internet as preferred sources of obtaining educational information, a greater emphasis might be placed on these media.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This study was approved by the Ethical Committee of Yazd University of Medical Sciences. We described the purpose of our survey to the respondents and they filled the questionnaire voluntarily. The questionnaires have been anonymous and only used for research purposes. Ethical Committee did not request that a written informed consent form was needed to apply the questionnaire.

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